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DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

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INTERNATIONAL APPLICATION NO.

PCT/KR00/00403

INTERNATIONAL FILING DATE

28 APRIL 2000

PRIORITY DATE CLAIMED

28 APRIL 1999

TITLE OF INVENTION

FIBER REINFORCED EPOXY RESIN PRODUCT AND METHOD FOR THE MANUFACTURE THEREOF

APPLICANT(S) FOR DO/EO/US

Dong Bo YANG

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

PCT Demand Form

PCT Request Form

Specifications, Claims and abstract

The following fees are submitted.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

- ☒ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000.00
- ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00
- ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$1000.00

ENTER APPROPRIATE BASIC FEE AMOUNT =

CALCULATIONS PTO USE ONLY

\$1,000.00

Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)). ☐ 20 ☐ 30

\$0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	20 - 20 =	0	x \$18.00
Independent claims	7 - 3 =	4	x \$80.00
Multiple Dependent Claims (check if applicable).			<input type="checkbox"/>

\$0.00

TOTAL OF ABOVE CALCULATIONS = \$1,320.00

- ☒ Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.

\$660.00

SUBTOTAL = \$660.00

Processing fee of \$130.00 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)). ☐ 20 ☐ 30 +

\$0.00

TOTAL NATIONAL FEE = \$660.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). ☐

\$0.00

TOTAL FEES ENCLOSED = \$660.00

Amount to be refunded: \$
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- a. ☐ A check in the amount of _____ to cover the above fees is enclosed.
- b. ☒ Please charge my Deposit Account No. 01-1944 in the amount of \$660.00 to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 01-1944. A duplicate copy of this sheet is enclosed.
- d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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24-645

REGISTRATION NUMBER

October 29, 2001

DATE

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FIBER REINFORCED EPOXY RESIN PRODUCT AND METHOD FOR THE
MANUFACTURE THEREOF

This application is a Continuation Application of PCT
5 International Application No. PCT/KR00/00403 filed on April
28, 2000, which designated the United States.

Field of the Invention

10 The present invention relates to a fiber reinforced
epoxy resin product and a method for manufacturing thereof;
more particularly, to a fiber reinforced epoxy resin product
comprising a hardened epoxy resin mixture including epoxy
resin, silica and reinforcing fiber materials such as glass
15 fiber, carbon fiber, aramid fiber or Kevlar fiber, and at
least one layer of fiber glass roving cloth and a method for
manufacturing thereof.

Background of the Invention

20 Conventionally, various methods such as a steel plate
bonding method, prestressing method and cross section
increasing method are used for reinforcing and repairing a
concrete structure.

25 The steel plate bonding method is adopted for
reinforcing bending strength of decks or shear strength of

piers of a bridge. The prestressing method is used with concrete casting when the amount of prestress is less than a desired level. The cross section increasing method is applied when the amount of reinforcing rods and the cross section of the concrete structure is insufficient.

Recently, the steel plate bonding method is most widely used among above-mentioned methods. In this method, steel plates are bonded to concrete surfaces via adhesive material such as epoxy resin in order to assure the transmission of shear stress and sufficient adhere strength between the concrete surfaces and the steel plates.

In such a method, however, continuous maintenance is needed to keep the sufficient adhere strength between the concrete surfaces and steel plates. And, where the concrete structure is exposed to seawater, it is difficult to achieve sufficient reinforcement or repair because of corrosion of the steel plates or problems related to durability of adhesive material. Also, the structural load increases as the number of the steel plates increases, wherein steel has a relatively high specific weight. Further, the steel plates are usually bonded to a bottom surface of the structure. Thus, lots of working hours and workers are needed, thereby increasing the costs.

By utilizing fiber reinforced plastics (FRP) panels instead of steel plates, the problems caused by corrosion can be prevented. However, FRP panels have such a low

strength that they function just as a cover for concrete surfaces.

In order to solve these problems, there have been suggested several improved methods such as those described
5 in Korean Laid-open Publication No. 174,161 having the title of "A epoxy resin panel for reinforcing concrete structure and a method for the manufacture thereof" filed by the applicant or Japanese Laid-open Publication No. 4-67946 having the title of "Thermosetting resin composite panel".

10 The resin panels suggested by these methods include metal wires as a reinforcing material. However, the metal wires are corroded after a long period of use, which makes the binding strength between resin material and wires decreased and, in turn, cracks or delamination is developed in the
15 resin panels. Further, weatherability and chemical resistance of the metal wires are not sufficient and, most of all, physical properties such as tension strength or compressive strength are deteriorated by the weakened binding strength.

20
Summary of the Invention

It is, therefore, an object of the present invention to provide a fiber reinforced epoxy resin product having
25 improved physical and chemical properties and also having better weatherability and chemical resistance by mixing

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epoxy resin with fiber chops and casting the mixture into a mold in which at least one layer of glass fiber roving cloth is arranged. It is another object of the present invention to provide a method for manufacturing such a fiber reinforced epoxy resin product.

A fiber reinforced epoxy resin panel according to the present invention can be used in various fields such as, for example, 1) reinforcement and repair of various kinds of concrete structures, 2) protection of surfaces of concrete structures from seawater, foul water, damages by freeze-thaw or other chemical actions, 3) reinforcement of tunnel linings, 4) corner casting panels for container terminal, 5) vehicle block, or the likes.

In accordance with a preferred embodiment of the present invention, there is provided a method for manufacturing a fiber reinforced epoxy resin product, comprising the steps of providing a mold for the product; applying a release agent to inner surfaces of the mold; providing at least one layer of glass fiber roving cloth in the mold; casting an unhardened epoxy resin mixture in the mold; pressing the epoxy resin mixture in the mold; hardening the epoxy resin mixture in the mold under a temperature between about 20°C and about 80°C for more than 30 minutes; releasing the hardened epoxy resin mixture from the mold; and curing the hardened epoxy resin mixture under a temperature between about 20°C and 35°C for about 24 hours

to form the product.

In accordance with another preferred embodiment of the present invention, there is provided a fiber reinforced epoxy resin product, comprising a hardened epoxy resin mixture including epoxy resin, silica and a fibrous material, wherein the fibrous material is a material selected from the group consisting of glass fiber, carbon fiber, aramid fiber and Kevlar fiber or a mixture thereof; and at least one layer of glass fiber roving cloth is arranged parallel to each other in the hardened epoxy resin mixture.

Brief Description of the Drawings

The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1A to 1F show an exemplified process of manufacturing the fiber reinforced epoxy resin product in accordance with the present invention;

Fig. 2 illustrates a cross-sectional view of a fiber reinforced epoxy resin panel manufactured in accordance with the method of the present invention;

Fig. 3 describes a cross-sectional view of a fiber reinforced epoxy resin panel bonded to a surface of a concrete structure for reinforcing in accordance with the

present invention;

Fig. 4A represents a plan view of a corner casting panel as an application of the fiber reinforced epoxy resin product in accordance with the present invention;

5 Fig. 4B is a side view of the corner casting panel shown in Fig. 4A;

Fig. 4C offers the installation of the panel in accordance with the present invention;

10 Fig. 5A to 5C provides vehicle blocks manufactured by the method in accordance with the present invention;

Fig. 6 sets forth an elevation view of the installed vehicle blocks; and,

15 Fig. 7 portrays a cross-sectional view taken along line I-I in Fig. 6.

Detailed Description of the Preferred Embodiments

20 Fig. 1A to Fig. 1F illustrate an exemplified process of manufacturing a fiber reinforced epoxy resin product in accordance with the present invention.

Step (a): a rectangular-shape mold (10) having a predetermined size is provided and dirt or other unnecessary materials are removed therefrom. The mold (10) can have various sizes and shapes depending on the use of a finished product. Preferably, the mold (10) is made of metal for
25 durability and can be utilized again after cleaning inner

surfaces thereof.

Step (b): a release agent (20) of conventional type is coated to inner surfaces of the mold (10) with a constant thickness. The release agent (20) facilitates the separation of the finished product from the mold.

Step (c): a first fiber mesh (30A) having meshes of predetermined sizes is allocated above the release agent (20) in the mold (10). Before this, the first fiber mesh (30A) is cut into a suitable size to fit in the mold and may be impregnated with epoxy resin in order to enhance the strength. Preferably, the epoxy resin has physical properties as followings: less than or equal to 380 mPas (380 csp) of viscosity, about 15 minutes of gel time, more than or equal to 1000 kg/cm² of compressive strength, more than or equal to 500 kg/cm² of bending strength, more than or equal to 800 kg/cm² of shear strength, more than or equal to 130 kg/cm² of adhesive strength, more than or equal to 0.02 of tensile fracture strain rate; 1.0×10^{-5} to 2.0×10^{-5} cm/cm/°C of coefficient of expansion; 50 to 75°C of heat deflection degree.

Step (d): Epoxy resin is mixed with reinforcing fiber materials in a ratio of 9 to 1 and the mixture is cast onto the first fiber mesh (30A) which was impregnated with the epoxy resin (a first casting process). The mixture includes the epoxy resin, a small amount of cement, silica and chopped reinforcing fiber material. The reinforcing fiber

material is a material selected from the group consisting of glass fiber, carbon fiber, agamid fiber and Kevlar fiber or the mixture thereof.

Preferably, the epoxy resin has following properties:

5 1.15 to 1.20 of specific weight; M70 to M80 of hardness; 19,000 to 24,000 cps of viscosity; less than or equal to 0.14% of absorptivity; less than or equal to 1.1% of shrinkage; and 180 to 230 of epoxy equivalent. The preferable properties of the silica are as followings: more
10 than or equal to 95% of purity; 2.25 to 2.65 of specific weight; 6.5 to 7.0 of Mohs hardness and 7 to 9 pH.

Step (e): After the first casting process, a second fiber mesh (30B) having same size and shape with the first fiber mesh (30A) is allocated in the mold and the epoxy
15 resin mixture is cast thereon (a second casting process). When the second casting process is finished, a third fiber mesh (30C) is allocated parallel to the first and second fiber mesh (30A, 30B) in the mold. The number of fiber mesh layers may be varied depending on the use of a finished
20 epoxy resin product. When it is used for reinforcement and repair of concrete structures, the finished epoxy resin product preferably has a plurality of layers and, e.g., the number of layers and the amount of the fibers are decided according to desired strength increase which may be
25 calculated by structural analysis.

When the first and second casting process is finished,

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vibrations are applied to the mold (10) by a vibrator such that the fiber meshes are moved into the epoxy resin mixture as shown in Fig. 1E.

After the vibrating process, the epoxy resin mixture is hardened under a temperature of 60°C for 30 minutes, and then pressed with a load of 1000 kg. Next, the epoxy resin mixture is hardened at a temperature of 80C for 3 hours.

Step (f): The hardened epoxy resin mixture is released from the mold (10) and cured under a temperature between 25 to 30°C for a predetermined period to form a fiber reinforced epoxy resin product (1). The mold (10) can be used again after the dirt is removed therefrom.

Fig. 2 shows a cross-sectional view of a fiber reinforced epoxy resin panel manufactured in accordance with the method of the present invention.

Fig. 3 is a cross-sectional view of a fiber reinforced epoxy resin panel bonded to a surface of a concrete structure for reinforcing.

First, a surface of a concrete structure (80) is pretreated for the reinforcement. A surface area to be reinforced and repaired is determined and the compression strength of the concrete structure is measured. The size of reinforcing panel is determined depending on the desired strength. Deteriorated parts of the concrete structure are removed and the surfaces are pretreated. Corroded steel reinforcing bars are repaired if required.

Next, the fiber reinforced epoxy resin panel (1) is fixed to the surface of concrete structure (80) via an anchor bolt or a chemical anchor bolt (84). The epoxy resin panel (1) is anchored to the surface with a gap of about 2 to about 6 mm by means of spacers. Adhesive epoxy resin will be injected into the gap between the panel and the surface. It is preferable that the gap between the panel and surface is as small as possible. Heads of the anchor bolts (84) are removed or covered by anchor caps to prevent corrosion. It is preferable that a distance from the anchor bolt (84) to the edge of the panel does not exceed 100 mm and a length of the anchor bolt is at least 2 to 3 times a depth of deteriorated parts. About 9 bolts are installed per 1 m² and generally a distance between the bolts is 30 cm.

Thereafter, adhesive epoxy resin (90) is injected into the gap. Before the injection, peripheries of the panel (1) are sealed with a sealant which is preferably the same type as the adhesive epoxy resin. Preferably, the adhesive epoxy resin (90) has same properties as the epoxy resin constituting the epoxy resin mixture but has lower viscosity. It is preferable to examine the properties of the adhesive epoxy resin (90) and working condition by mock-up test. The adhesive epoxy resin (90) is injected into the gap by an injection pressure of, e.g., 0.5 to 2.5 kg/cm². Injection process starts at a low pressure and the pressure is slowly increased in order to prevent the generation of air bubbles.

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This process is performed at a temperature of 5 to 30°C.

After the injection process is finished, the adhesive epoxy resin is cured for 3 days. The epoxy resin panels are protected from rainwater or dirt by covering it with vinyl
5 sheet or the like. Heads of anchor bolts can be removed for good appearance.

Fig. 4A shows a plan view of a corner casting panel as an application of the fiber reinforced epoxy resin product in accordance with the present invention. Also, Fig. 4B is
10 a side view thereof and Fig. 4C shows the installation of the panel.

A corner casting panel (100) is an article for protecting surfaces (110) of container terminal from being damaged by corner portions of container boxes. These panels
15 (100) are arranged to support the corners of the container boxes.

These corner casting panels are manufactured by the same process as above described except that more fiber mesh layers are included and compositions of some components are
20 different in order to increase the strength. The panels can be manufactured in various sizes such as, e.g., {420 mm X 1350 mm X 20 mm}, {420 mm X 600 mm X 20 mm} or {1000 mm X 1350 mm X 20 mm}.

Figs. 5A to 5C show vehicle blocks manufactured by the
25 method in accordance with the present invention.

These vehicle blocks (200, 200A, 200B) are

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manufactured by the same process as above described in various sizes. The vehicle blocks (200, 200A, 200B) have through holes (212) for fixing bolts (210). Preferably, the fixing bolts (210) are more than 2 times longer than the heights of the blocks (200, 200A, 200B). The numbers of the through holes (212) can be changed depending on the length of the block.

Fig. 6 is an elevation view of the installed vehicle blocks. Fig. 7 shows a cross-sectional view taken along line I-I in Fig. 6.

These vehicle blocks are manufactured by the same process as above described except that the epoxy resin mixture preferably has compositions as followings: 10 to 30 wt% of epoxy resin, 20 to 39 wt% of silica, 30 to 68 wt% of rubbles and 0.01 to 1 wt% of reinforcing materials, and more preferably, 13.64 wt% of epoxy resin, 39.59 wt% of silica, 46.70 wt% of rubbles and 0.07 wt% of reinforcing fiber materials.

Preferably, the fiber mesh has properties as followings: 550 to 610 g/m² of weight, more than or equal to 6.3 of density, more than or equal to 1,500 kg/mm² of tensile strength and more than or equal to 1,295 kg/mm² of bending strength.

Also, the epoxy resin mixture may include inorganic materials having refractory and self-extinguishing characteristics, e.g., aluminum hydroxide, antimony oxide or

hydro bromide. In order to maintain the structural strength, it is preferable that the epoxy resin mixture does not include the inorganic materials more than 5 wt% relative to the total weight of the epoxy resin mixture.

5 As shown in the drawings, the vehicle blocks (200, 200C) are aligned in a predetermined interval. The interval is corresponding to a width of vehicles and the vehicle blocks (200B) having inclined surface are allocated at both ends of the vehicle block line.

10 The vehicle blocks (200) are fixed to desired places with the bolts (210) after surfaces (300) of the places are cleaned. Next, peripheries of each block are sealed by sealant and then resin inlet and air outlet are formed. Thereafter, adhesive epoxy resin (220) is injected into an
15 interface between the surface and the block for preventing permeation of water and assuring that the blocks are firmly fixed to the surfaces. Preferably, an adhesive epoxy resin layer has a thickness of about 2 mm to 6 mm. Injection process starts at a lower pressure which is increased to
20 higher pressure gradually and slowly in order to prevent generation of air bubbles. It is preferably that the injection pressure is 0.5 to 2.5 kg/cm². The adhesive epoxy resin has the same properties as above described except that it has lower viscosity and a gel time of about 3 hours.

25 After the injection process, the adhesive epoxy resin is cured more than 3 hours. An epoxy based paint may be

applied to the surface of the vehicle block. Above described process also can be applied to manufacture the corner casting panels.

5 Examples

Examples of manufacturing the concrete reinforcing panels and vehicle blocks are described hereinafter.

Example 1

10 A mold having a size of 1000 mm X 1000 mm X 11 mm was prepared. A release agent was applied to inner surfaces of the mold. At least three layers of fiber mesh were arranged in the mold. Thereafter, an epoxy resin mixture including 30.1 wt% of epoxy resin, 0.5 wt% of cement, 69.3 wt% of
15 silica and 0.1 wt% of chopped fibers was cast into the mold and then the mold was vibrated. After hardening process at a temperature of 60°C for 30 minutes, the epoxy resin mixture was pressurized with a load of 1,000 kg. The epoxy resin mixture was further hardened at a temperature of 80°C
20 for 3 hours and then released from the mold. The hardened epoxy resin mixture was cured at a temperature of 25 to 30°C and a humidity of 40 to 50% for 3 days. Properties of finished epoxy resin panels were tested and a result obtained is as followings:

25

TABLE 1

Mechanical properties		Test result	Remarks
Compression strength (kg/cm ²)		800	fracture strain rate 0.017
Direct tensile strength (kg/cm ²)		340	fracture strain rate 0.017
Bending strength (kg/cm ²)		400	
Modulus of Elasticity	Compression (kg/cm ²)	74,000	
	Tension (kg/cm ²)	34,000	
Poisson's ratio	Compression	0.34	
	Tension	0.22	
Fracture strain rate	Compression	0.020	0.017 - 0.037
	Tension	0.010	0.010 - 0.014
Coefficient of thermal expansion		6.5×10^{-6}	
Weatherability	Cured in the water	Substantially not affected	For 3 months
	Exposed to the air	Substantially not affected	For 3 months
Chemical resistance		Strong resistance to acid and alkali	

As shown in table 1, the compression strength and
 5 tensile strength of the fiber reinforced epoxy panel is
 higher than those of concrete and the bending strength is
 also relatively high.

It was found from the specimens cured in the water and
 in the air at a low temperature that the properties of the
 10 epoxy resin product in accordance with the present invention

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were not affected by the weather conditions such as temperature and humidity, and the period disposed in the water. The epoxy resin product also had strong resistance to the acids and alkalis. It was thus proved that the epoxy resin product was appropriate to use in places under severe condition such as seawater, sewage and exhaust gas of vehicles.

Example 2

10 A mold having a size of 800 mm X 1500 mm X 11 mm was prepared. A release agent was applied to inner surfaces of the mold. At least three layers of fiber mesh were arranged in the mold. Thereafter, an epoxy resin mixture including 23.9 wt% of epoxy resin, 1.5 wt% of cement, 74.5 wt% of silica and 0.1 wt% of chopped fibers was cast into the mold and then the mold was vibrated. After hardening process at a temperature of 60°C for 30 minutes, the epoxy resin mixture was pressurized with a load of 1,000 kg. The epoxy resin mixture was further hardened at a temperature of 80°C for 3 hours and then released from the mold. The hardened epoxy resin mixture was cured at a temperature of 25 to 30°C and a humidity of 40 to 50% for 3 days. Properties of finished epoxy resin panels were tested and the results were substantially same as those in Table 1.

Example 3

A steel mold having a size of 170 mm X 150 mm X 1000 mm was prepared. A release agent, e.g., 700-NC or PS-100, was applied to inner surfaces of the mold. Layers of fiber mesh were arranged in the mold. Thereafter, an epoxy resin mixture including epoxy resin, silica, reinforcing fiber, rubbles, cement and inorganic materials was cast into the mold and then air bubbles were removed from the mold. The remaining amounts of the air bobbles were below 4%. The epoxy resin mixture was pressurized with a load of 800 to 1,000 kg and hardened for 1 to 3 hours and then released from the mold. The hardened epoxy resin mixture was cured at a temperature of 25 to 30°C and a humidity of 40 to 50% for 24 hours. The properties of the finished epoxy resin vehicle blocks were tested and a result obtained is as followings:

TABLE 2

Properties		Test results	Concrete
Compression strength (kg/cm ²)		1128	300
Direct tensile strength (kg/cm ²)		360	340
Bending strength (kg/cm ²)		450	400
Weatherability	Cured in the water	Substantially not affected	Affected
	Exposed to the air	Substantially not affected	Affected
Chemical resistance		Strong resistance to acid and alkali	Weak

As shown in Table 2, the compression strength and tensile strength of fiber reinforced epoxy resin vehicle block are higher than those of concrete and the bending strength is also relatively high. Also, the durability was better than that of concrete. It was found from the specimens cured in the water and in the air at a low temperature that the properties of the epoxy resin product in accordance with the present invention were not affected by the weather conditions such as temperature and humidity, and the period disposed in the water. The epoxy resin product also had strong resistance to the acids and alkalis. It was thus proved that the epoxy resin product was appropriate to use in places under severe condition such as seawater, sewage and exhaust gas of vehicles.

While the invention has been shown and described with respect to the preferred embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A method for manufacturing a fiber reinforced epoxy resin product, comprising:

- 5 providing a mold for the product;
 applying a release agent to inner surfaces of the mold;
 providing at least one layer of glass fiber roving cloth
in the mold;
 casting an unhardened epoxy resin mixture in the mold;
10 pressing the epoxy resin mixture in the mold;
 hardening the epoxy resin mixture in the mold under a
temperature between about 20°C and about 80°C for more than
30 minutes;
 releasing the hardened epoxy resin mixture from the mold;
15 and
 curing the hardened epoxy resin mixture under a
temperature between about 20°C and 35°C for about 24 hours
to form the product.

- 20 2. The method of claim 1, wherein the epoxy resin mixture
includes epoxy resin, silica and reinforcing fibrous
material, the reinforcing fibrous material being a material
selected from the group consisting of glass fiber, carbon
fiber, aramid fiber and Kevlar fiber or a mixture thereof.

25

3. The method of claim 2, wherein the epoxy resin mixture

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further includes cement.

4. The method of claim 2, wherein the epoxy resin mixture further includes an inorganic material having refractory and self-extinguishing characteristics.

5. The method of claim 4, wherein the inorganic material is selected from the group consisting of Aluminum hydroxide, antimony oxide and hydro bromide.

6. The method of claim 1, the method further comprising a step of impregnating at least one layer of the glass fiber roving cloth with epoxy resin.

7. The method of claim 1, the method further comprising a step of removing air bubbles from the unhardened epoxy resin mixture.

8. The method of claim 7, wherein the removal of the air bubbles is performed by vibrating the mold.

9. A fiber reinforced epoxy resin product, comprising.

a hardened epoxy resin mixture including epoxy resin, silica and a fibrous material, the fibrous material being a material selected from the group consisting of glass fiber, carbon fiber, aramid fiber and Kevlar fiber or a mixture

thereof;

at least one layer of glass fiber roving cloth arranged parallel to each other in the hardened epoxy resin mixture.

- 5 10. A method for manufacturing a fiber reinforced epoxy resin product, comprising:

providing a mold for the product;

applying a release agent to inner surfaces of the mold;

providing at least one layer of glass fiber in the mold;

- 10 casting an unhardened epoxy resin mixture in the mold;

pressing the epoxy resin mixture in the mold;

hardening the epoxy resin mixture in the mold under a temperature between about 20°C and about 80°C for more than 30 minutes;

- 15 releasing the hardened epoxy resin mixture from the mold; and

curing the hardened epoxy resin mixture under a temperature between about 20°C and 35°C for about 24 hours to form the product.

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11. A method for manufacturing a fiber reinforced epoxy resin panel, comprising:

providing a mold for the panel;

applying a release agent to inner surfaces of the mold;

- 25 providing at least three layers of glass fiber roving cloth in the mold;

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casting an unhardened epoxy resin mixture in the mold;
pressing the epoxy resin mixture in the mold;
hardening the epoxy resin mixture in the mold under a
temperature between about 60°C and about 80°C for more than
5 30 minutes;
releasing the hardened epoxy resin mixture from the mold;
and
curing the hardened epoxy resin mixture under a
temperature between about 25°C and 30°C and a humidity
10 between about 40% and about 50% for about three days to form
the panel.

12. The method of claim 11, wherein the epoxy resin mixture
includes epoxy resin, silica and reinforcing fibrous
15 material, the reinforcing fibrous material being a material
selected from the group consisting of glass fiber, carbon
fiber, aramid fiber and Kevlar fiber or a mixture thereof.

13. The method of claim 11, the method further comprising a
20 step of impregnating at least one layer of the glass fiber
roving cloth with epoxy resin.

14. A fiber reinforced epoxy resin panel, comprising.

a hardened epoxy resin mixture including epoxy resin,
25 silica and a fibrous material, the fibrous material being a
material selected from the group consisting of glass fiber,

carbon fiber, aramid fiber and Kevlar fiber or a mixture thereof;

at least three layer of glass fiber roving cloth arranged parallel to each other in the hardened epoxy resin mixture.

5

15. A method for manufacturing a fiber reinforced epoxy resin product, comprising:

providing a mold for the product;

applying a release agent to inner surfaces of the mold;

10 providing at least three layers of glass fiber roving cloth in the mold;

casting an unhardened epoxy resin mixture in the mold;

pressing the epoxy resin mixture in the mold;

15 hardening the epoxy resin mixture in the mold under a temperature between about 60°C and about 80°C for about one to about three hours;

releasing the hardened epoxy resin mixture from the mold; and

20 curing the hardened epoxy resin mixture under a temperature between about 20°C and 35°C and a humidity between about 30% and about 60% for about 24 hours to form the product

25 16. A method of claim 15, the method further comprising a step of removing air bubbles from the unhardened epoxy resin mixture such that the amount of the air bubbles therein is

maintained below about 4%.

17. A method of claim 15, wherein the epoxy resin mixture includes epoxy resin, silica, rubbles and reinforcing
5 fibrous material, the reinforcing fibrous material being a material selected from the group consisting of glass fiber, carbon fiber, aramid fiber and Kevlar fiber or a mixture thereof.

10 18. A method of claim 17, wherein the epoxy resin mixture further includes an inorganic material having refractory and self-extinguishing characteristics.

15 19. A vehicle block structure having a predetermined height, comprising:

a body including a hardened epoxy resin mixture and glass fiber roving clothes, the hardened epoxy resin mixture containing epoxy resin, silica, rubbles and reinforcing fibrous material;

20 a plurality of through holes arranged in a direction of elevation of the structure; and

a plurality of bolts having a length greater than the height of the structure and being arranged in the through hole to fix the structure to a desired place.

25 20. A vehicle block structure of claim 19, the structure

further comprising an adhesive epoxy resin layer in order to
fix the structure to a desired place.

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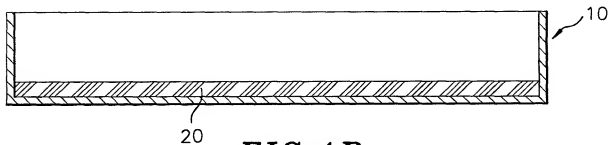
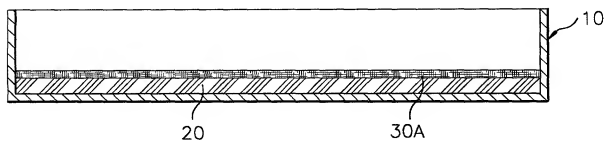
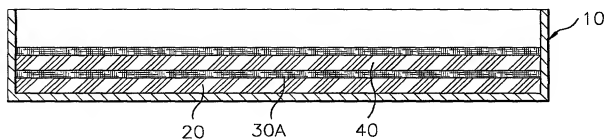
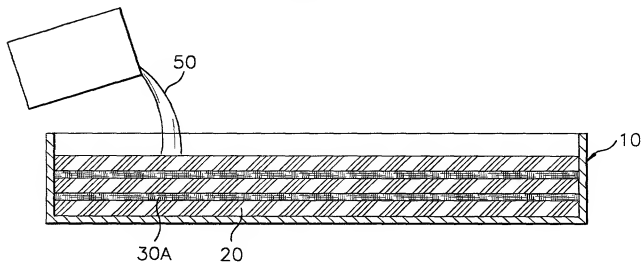
FIG. 1A**FIG. 1B****FIG. 1C****FIG. 1D**

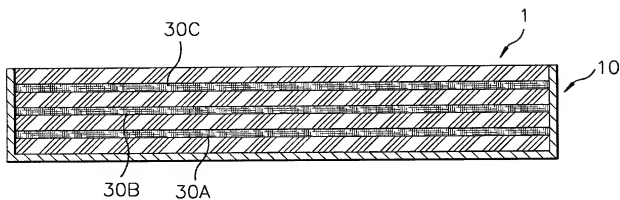
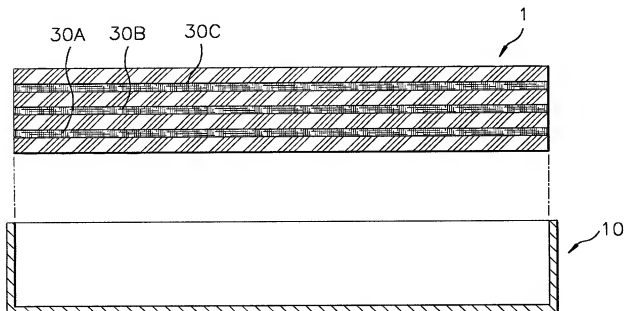
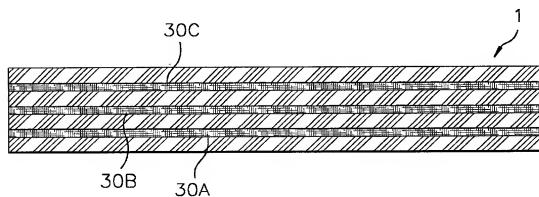
FIG. 1E**FIG. 1F****FIG. 2**

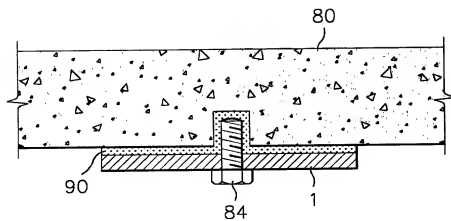
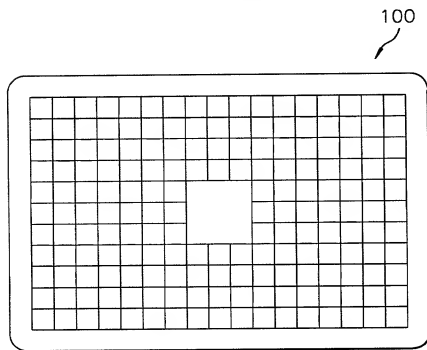
FIG. 3**FIG. 4A****FIG. 4B**

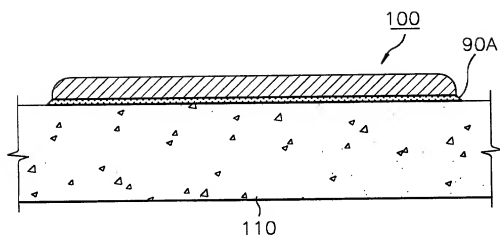
FIG. 4C

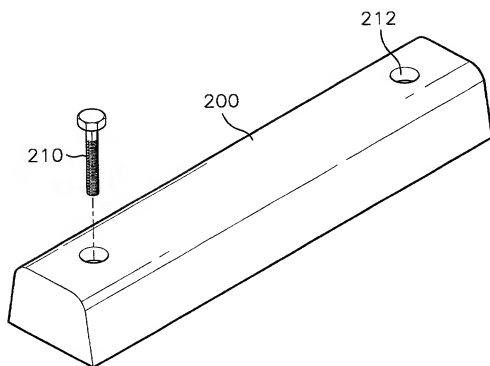
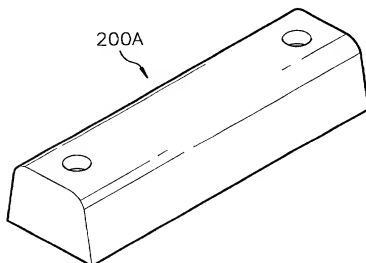
FIG. 5A**FIG. 5B**

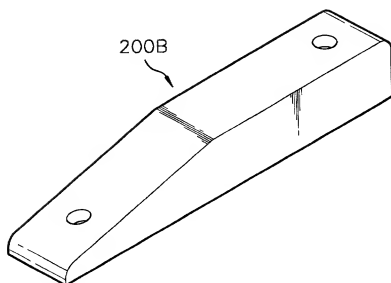
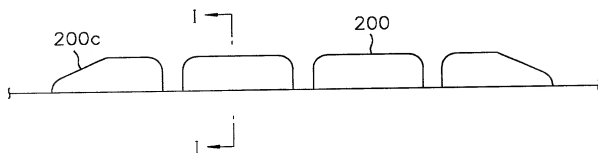
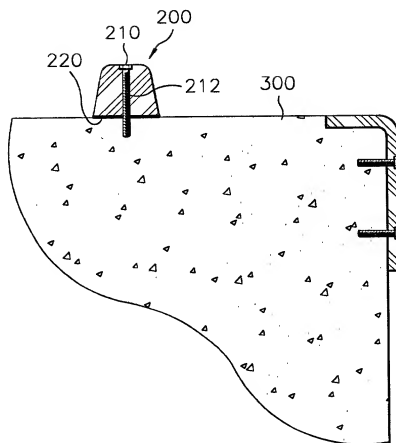
FIG. 5C*FIG. 6*

FIG. 7



ANDERSON KILL & OLICK, P.C.
DECLARATION AND POWER OF ATTORNEY

This is a continuation application of International Application No. PCT/KR00/00403 filed on April 28, 2000 and designating the United States of America.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed at 201 below), or an original, first and joint inventor (if plural names are listed at 201 et seq. below), of the subject matter which is claimed and for which a patent is sought on the invention entitled **FIBER REINFORCED EPOXY RESIN PRODUCT AND METHOD FOR THE MANUFACTURE THEREOF**

the specification of which:

☒ [X] is attached hereto

☐ [] was filed on _____ as Application Serial No. _____ (for declaration not accompanying application) with amendment(s) filed on _____ (if applicable)

☐ [] was filed as PCT International Application Serial No. _____ on _____ and was amended under PCT Article 19 on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119/§172 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED PRIOR TO THE FILING DATE OF THE APPLICATION			
APPLICATION NUMBER	COUNTRY	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119/172
1999-15219	Republic of Korea	28, 04, 1999	YES [x] NO []
1999-38063	Republic of Korea	08, 09, 1999	YES [x] NO []
			YES [] NO []

I hereby claim the benefit under Title 35, PCT application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior PCT application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior PCT application and the national filing date of this application:

APPLICATION NUMBER	FILING DATE	STATUS		
		PATENTED	PENDING	ABANDONED
PCT/KR00/00403	28, 04, 2000		X	

POWER OF ATTORNEY: As a named inventor, I hereby appoint Michael N. Melier (Reg. No. 20,779), Eugene Lieberstein (Reg. No. 24,645), Richard B. Klar (Reg. No. 31,385) and Jack Matalon (Reg. No. 22,441) whose address is **Anderson Kill & Ollick, P.C., 1251 Avenue of the Americas, New York, New York 10020-1182**, as my attorneys, to prosecute this application, and to transact all business in the Patent and Trademark Office connected therewith.

10020-1182

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204	2	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME
	0	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	4	POST OFFICE	POST OFFICE ADDRESS		STATE OR COUNTRY ZIP CODE
205	2	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME
	0	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	5	POST OFFICE	POST OFFICE ADDRESS		STATE OR COUNTRY ZIP CODE

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201 <i>Dong Hye Yang</i>	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE <i>October 22nd, 2001</i>	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	
DATE	DATE	

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